Texas Highways

March, 1960 35c

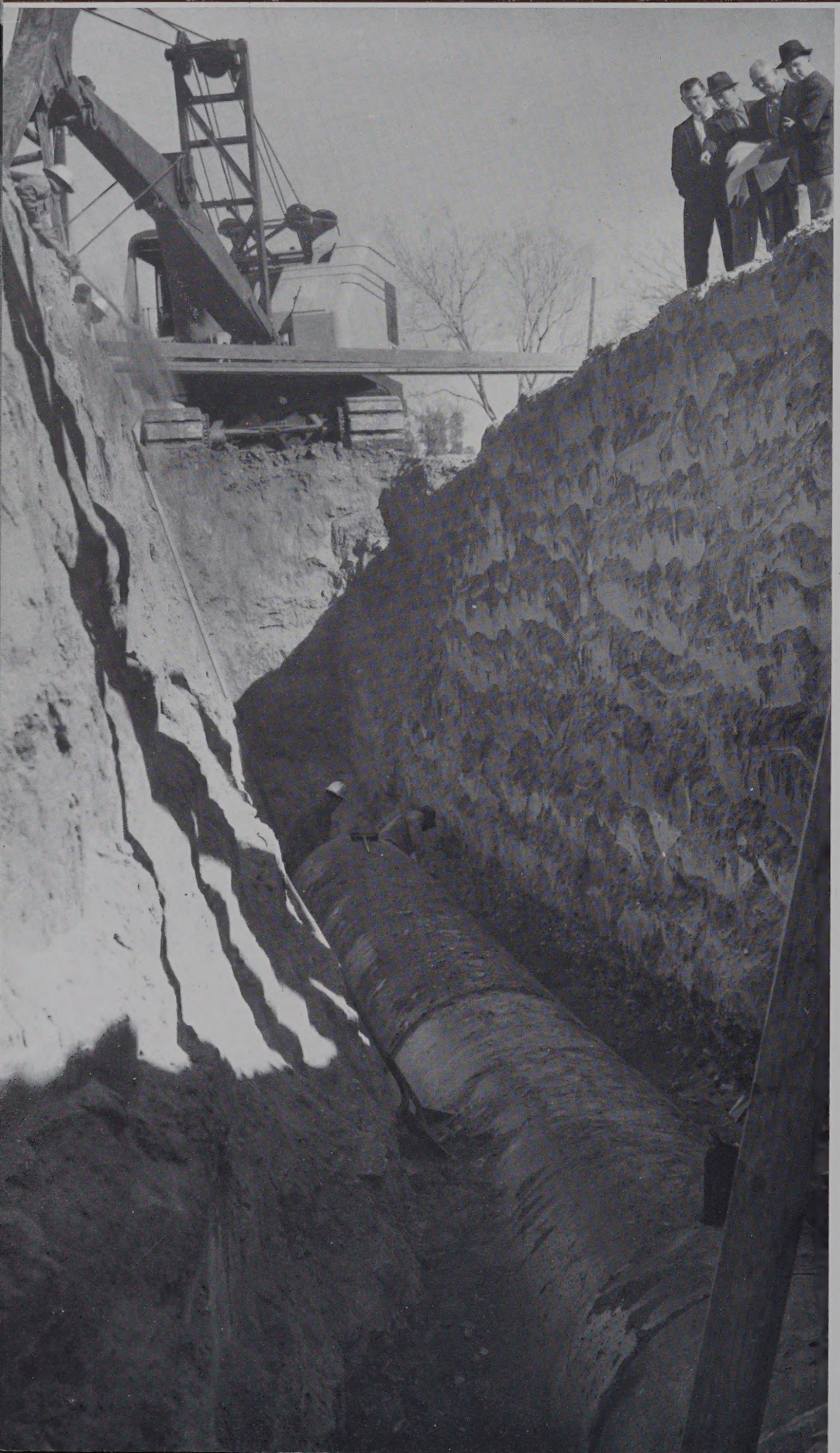
Texas Highways

Volume 7 • Number 3

March, 1960

Contents

Utility Adjustment	2
Preventive Maintenance	5
Research in Asphalt Quality Control	6
Curb Brush	12
Warehouse: Reorganized and Systemized	14
Carver New D-10 Head	19
Construction Staking by Triangulation	20
In the Public Eye	24
Headlight Protector	26
Over the Highways	27



Utility

A long-awaited decision by the Texas Supreme Court in January broke an eight-month silence regarding one of the more complex right of way problems the Highway Department faces wherever the Interstate Highway System is being built. The problem involves payment for relocating utility adjustments.

What are utility adjustments? The term "utility adjustments" means clearance of utility facilities on right of way required for highway construction. Such adjustments may range from complete removal and rerouting of lines, to only a matter of moving lines to the edge of a new right of way. Utility lines, either public, private, or cooperative, may involve pow-

Out in the field, Right of Way Division men Charles Neal and Jim Crate join the two District Right of Way Agents, Tom Gardner and Bill Kriegel, in reviewing plans for a utility relocation near a strip of Interstate Highway 35 under construction.

Adjustment

Robert C. Brown, Senior Office Assistant
Right of Way Division

er transmission, telephone and telegraph pole lines, or oil, gas, and water pipelines.

Before the Highway Department inherited the utility-adjustment problem in 1956, along with the responsibility of acquiring right of way, counties and cities were required to buy and clear all right of way before transferring property to the State for road-construction projects. For this reason, the State was never faced with the need for a reimbursement policy for utility adjustments.

Since passage of the new interstate-highway legislation, Federal-Aid Highway Act of 1956, the Federal Government reimburses each state 90 per cent of the cost for building its share of the National System of Interstate and Defense Highways, if the State will finance the remaining 10 per cent cost.

The Fifty-fifth State Legislature, following in the footsteps of this Act, passed House Bill 179 of which Section 4A required the State to pay for any and all required utility-adjustment work on the Interstate System, if eligible for Federal reimbursement, regardless of by what right a utility occupied the present location.

As a consequence of Section 4A, an impasse developed. The Attorney General ruled that Section 4A was unconstitutional since it entitled utility owners to reimbursement for any and all adjustments on interstate highways. The City of Austin and the City of Dallas, as municipal owners of utilities, filed separate suits against the State as a result of the Attorney General's action. After progressing through the lower courts, the two suits were finally consolidated for submission of appeal to the Supreme Court. The State maintained that in cases where utilities were allowed free access to locate on existing highway right of way by permit, it was the utility's responsibility to pay for the adjustments necessary when the State should eventually utilize the remainder of highway property. The municipal utilities took the stand that since the State was responsible for creating the necessary adjustment, the utilities should be reimbursed for any adjustment cost resulting from new interstate highway construction.

As an aftermath of this impasse, the Highway Department classified utility adjustments into two kinds—eligible and ineligible. The eligible types were those utility adjustment claims recognized as reimbursable by the State. The ineligible types were those utility adjustments which the State considered nonreimbursable, at least until a time the Supreme Court should rule otherwise.

For example, if the adjustment involved utility lines located on a utility's private right of way, which may include right by easement, fee, or deed, it was considered an eligible adjustment as there was no question of the State picking up the tab by reimbursing this type of adjustment work. However, in cases where a utility line was on existing highway right of way by permit, the utility owner had been granted access on public right of way by permission only, and no fee charged. This was considered an ineligible adjustment by the State, and therefore, nonreimbursable.

During this interim, the Highway Department and the utility owners continued to join in contractual

A utility adjustment agreement between a utility owner and the State undergoes rigid screening by both the district office and the owner before being submitted for payment approval to the Right of Way Division in Austin. Giving utility agreement plans last-minute check-up are Tom Gardner and Bill Driegel, Right of Way Agents, District 14.

agreements with the understanding utilities would adjust all lines regardless of eligibility, but State reimbursement would be limited to eligible adjustments until the time the Supreme Court decides otherwise.

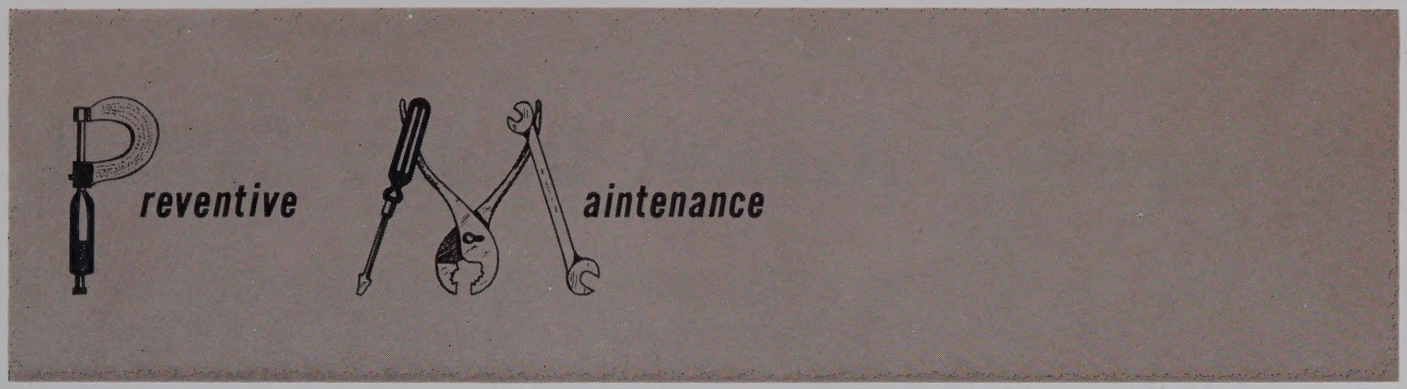
That time came on January 6, 1960. The Supreme Court ruled that the State is responsible for paying the cost of removing or relocating utility lines which are on public right of way by right of permit on the Interstate Highway System, provided such work is eligible for Federal reimbursement. As a result of the Supreme Court's decision, 280 utility adjustments (as of January 15, 1960) formerly classified as ineligible became eligible for reimbursement, totaling more than $3,026,000.

Based upon estimates presently available, an amount of $28,000,000 will be made in reimbursements during the entire period of interstate highway construction for utility adjustments which would have been formerly classified as ineligible. This estimate involves $24,000,000 reimbursement to privately owned utilities and $4,000,000 reimbursement for municipally owned utilities such as water and light systems.

On the other hand, reimbursement for adjustment of utility facilities located on private right of way on the Interstate System, which were not involved in the Supreme Court decision, will total an estimated additional $24,000,000. Estimates for the total cost of utility work on the entire Interstate System come to approximately $52,000,000.

In addition to the foregoing, the Highway Department is also involved in utility adjustments under the 50-50 Right of Way Program, which was not involved in the Supreme Court ruling. Under this program, cities and counties are reimbursed by the State one-half of the cost of utility adjustments necessitated in building U. S. and State highways. This is a separate program from that of the Interstate System.

Once a utility adjustment agreement is received by the Right of Way Division, the submission is reviewed for reimbursement eligibility and design requirements, by such Right of Way Agents as Bob Smith and Charles Clinger, under the supervision of O. W. "Dutch" Holzmueller, Senior Right of Way Agent.



Vehicles bearing numbers painted on the ethyl tank pull up there. Others stop at the regular supply.

Like most districts, Amarillo has two gasoline pumps in its district service station, one containing regular and one ethyl. Until a new system was inaugurated recently, almost every driver stopped at the ethyl pump. The simple plan to activate the pump of regular gasoline has been to paint on the ethyl pump the numbers of vehicles entitled to use this fuel. Those not numbered must pull over to the supply of regular.

Committee Decides Needs

Since last October, the Amarillo District has had a three-man group, which District Engineer Charles W. Smith calls the "Equipment Needs Committee," meeting at least once a month to review the needs for new or additional equipment in the District. The chairman, J. M. Harris, District Maintenance Engineer, submits the list of equipment the committee decides is necessary. After approval, the committee then has the follow-up responsibility of preparing the necessary requests and requisitions. District Equipment Supervisor Joseph S. Gaines and Senior Maintenance Superintendent Will A. Riney are committee members. Gaines will determine the need for replacement equipment when present equipment wears out or needs replacing. He advises, however, with the rest of the committee on these items, so they may acquaint him with replacement units which may have escaped his notice.

Research in Asphalt Quality Control

PART I: CONSISTENCY OF ASPHALT

What is it and how is it measured?

This is the first in a series of five articles by Dr. Traxler on one of the more important research studies underway at the Texas Transportation Institute of the A & M College System for the Texas Highway Department. The A & M College System has been conducting a cooperative program of research for the Highway Department since January 1953. Some 23 formal research projects have been initiated under this cooperative program with the T.T.I., nine of which have been completed with a final report. There are presently fourteen active projects, including four utilizing Federal fund participation.

This series of articles will present the progress of one phase of a coordinated research program being conducted by the T.T.I. in conjunction with the asphalt section of the Materials and Tests Division of the Highway Department, aimed at developing ways of improving the quality of asphaltic paving in Texas.

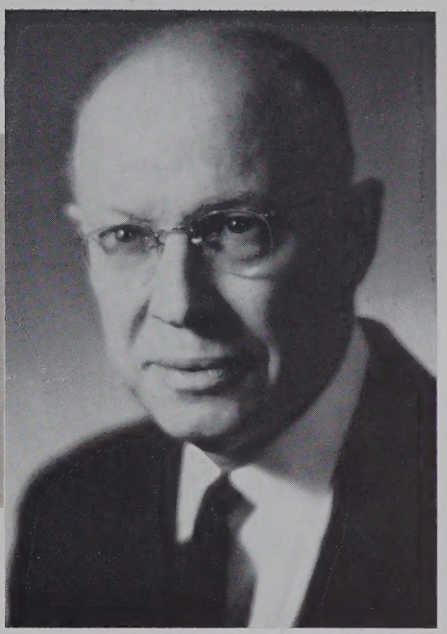
The properties of asphalt which offer resistance to deformation by an applied force are called its consistency. Two kinds of deformation are involved—viscous and elastic. Any elastic deformation which occurs will eventually disappear after the applied force is removed. Viscous deformation, on the other hand, is not recoverable. Most asphalts show both elastic and viscous behavior, depending on the rate at which the force is applied. When a bitumen is deformed rapidly (at a high rate of shear) the stresses established will tend to result from deformation of elastic elements within the asphalt. At low rates of deformation the stresses are likely to be due predominately to viscous flow. In most paving asphalts elasticity becomes evident only in vibration of the material.

Basically, the viscosity of any fluid depends upon the internal friction, which resists deformation or flow when a force is applied. This is known as the coefficient of viscosity, or more simply, the viscosity of the material. Viscosity expressed in units of length, weight, and time can be measured in properly designed equipment. The metric unit is the poise, expressed in grams per centimeter-second. The English unit is the reyn, expressed in pounds per inch-second. One reyn equals 6,900,000 poises.

The stresses normally exerted on a pavement by moving vehicles are of the order of 10^7 dynes per square centimeter. While there usually is some elastic deformation under such stress, the highway engineer is most concerned with the viscous deformation (viscosity) of the asphalt at any given temperature. Stress in a pavement is also caused by soil movement and thermal contraction. These forces are sometimes more pronounced than those produced by traffic. Since the *rates of shear* brought about in an asphalt road by excessive cooling are

Dr. Traxler, who is authoring this series of articles for TEXAS HIGHWAYS, came to the Texas Transportation Institute on February 1 of last year. He is Research Engineer for TTI and a professor at A&M. His background includes 21 years as supervisor of asphalt research for Texaco, Inc., and prior to that, he was in charge of research for Barber Asphalt Co. for nine years.

Born at Lamar, Colorado, on December 20, 1897, Dr. Traxler holds bachelor of arts and master of arts degrees in chemistry from the University of Colorado, and a doctor of philosophy degree in physical chemistry from the University of Wisconsin.



Dr. R. N. Traxler

extremely low, the stresses so developed will be related to the viscous elements in the binder. Thus, in many situations the permanent or viscous flow may overshadow the non-permanent or elastic deformation. If the viscosity of the asphalt is greater than about 8 to 10 million poises at 77°F the pavement is likely to crack because of the stresses developed at low temperatures.

Although other factors are involved, the life of a bituminous pavement will depend to a great extent upon the consistency of the asphalt at any given temperature. Since the viscous element of consistency is of such great importance, it is essential that the viscosity-temperature coefficient be maintained as low as possible in road-building asphalts. This is commonly expressed as the need for a material possessing a low temperature susceptibility. It is required that the binder be soft enough that the road will not crack at low temperatures because of traffic, soil, or thermal stresses. But, the asphalt also must be hard enough at maximum service temperature (160°F) to give stability to the highway under traffic. Finally, the binding material must be sufficiently fluid at temperatures that can be economically and satisfactorily used during transportation and mixing with stone. A hot-mix pavement must be prepared at a temperature low enough to prevent damage to the asphalt. The mixing temperature required to give a satisfactory film of asphalt on each piece of aggregate is very important. That temperature will depend on the consistency of the bitumen.

At this point it may be well to briefly review the history of asphalt and the methods developed for evaluating its consistency. Asphalt has been used by man longer than any other material related to or derived from petroleum. His first acquaintance with this black adhesive came with the discovery of surface deposits of soft bitumens, which could be used without processing. The early artisan paid little attention to the consistency of the asphalt other than to select a material which could be conveniently used for a particular application.

By the latter part of the Nineteenth Century, the pressure for paved streets and sidewalks resulted in an increased demand for native asphalts. It then became evident that proper use of most native asphalts required a modification of their hardness or consistency. This was accomplished by fluxing or softening the native asphalt by heavy oils or residues resulting from the distillation of petroleum. The heavy bottoms from asphaltic or mixed-base crude oils were found to be most suitable as fluxes.

It was not too difficult to devise an apparatus for evaluating the consistency of the hot-fluxed asphalt. The material to be tested was placed in a vessel that could be maintained at a constant temperature. The receptacle had a round hole of fixed diameter in the bottom into which a stopper was inserted. After the entire assembly and contents were brought to the desired temperature, the stopper was removed and a record made of the time required for a fixed volume of the material to flow through the hole. This type of viscosimeter possessing differ-

ent forms and dimensions became known as the Engler (Germany), Redwood (Great Britain), Barbey (France), and Saybolt (United States). The original American instrument is now called the Saybolt-Universal, and a modification with a larger hole has been given the name Saybolt-Furol. The latter instrument was developed for the rapid evaluation of *fuel oils and road oils,* from which the name Furol was derived.

These apparatus served to evaluate and control asphaltic materials at manufacturing and handling temperatures. But, the problem still remained of how to measure the consistency of an asphalt at service temperatures (below 120°F). To start with, a small lump of the finished asphalt was chewed like a piece of chewing gum. This was not such a bad idea since the human mouth is a fairly accurate constant temperature bath. With practice and experience an operator could become adept at evaluating the consistency of the asphalt at the temperature of his mouth (about 98°F). In fact, as late as 1920 men were supervising the manufacture of asphalt who put great trust in this procedure. They considered it more reliable than the "new-fangled" penetrometer being used by the laboratory "boys."

The penetrometer was first designed by H. C. Bowen at Columbia University in 1889. Acceptance of the apparatus was slow and awaited improvements by A. W. Dow, Clifford Richardson, and C. N. Forrest. These men were all pioneers in asphalt technology. By 1910 the penetrometer was an established instrument for evaluating the consistency of road-building asphalts at atmospheric temperatures. Gradually, the temperatures used were established at 32°F (0°C), 77°F (25°C) and 115°F (46.1°C).

During the past 50 years many millions of penetration tests have been made on asphalts of different kinds and consistencies. It has become common practice to grade asphalts by the ASTM (American Society for Testing Materials) penetration test at 77°F under a load of 100 grams for five seconds. However, as asphalt technology became less of an art and more of a science, the inadequacy of the penetration test became apparent. It did not tell all that should be known about an asphalt. Valiant efforts have been made to convert penetration data into absolute viscosities (centimeter-gram-second units). Also, attempts were made to interpret flow characteristics in terms of penetration values.

As was mentioned at the beginning of this article, viscosity is a fundamental property of any fluid. For asphalts it offers a truer picture than can be obtained by empirical tests such as penetration and softening point. Also, viscosity measurements are very sensitive and bring to light differences not detected by the empirical tests. During the past 25 years much effort has been devoted to the

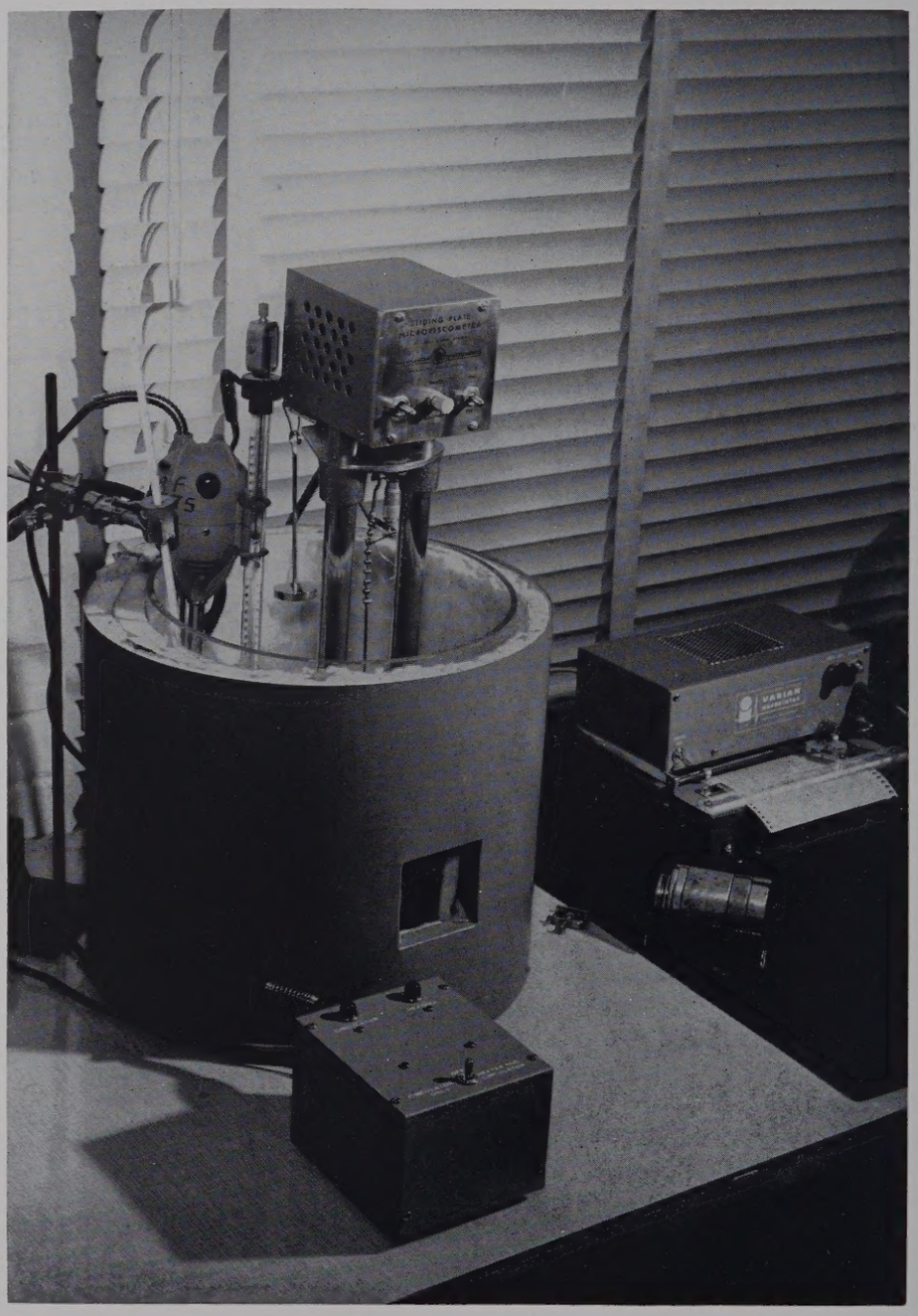


Figure 1—Microfilm viscometer and auxiliary equipment.

development of absolute viscometers for evaluating materials possessing a wide range of consistency. The consistencies of asphalts, caused by either differences in source, kind, and degree of processing, or temperature of test, may now be satisfactorily compared. Asphalt cements—either cold or hot, asphaltic cutbacks of all grades, asphalt emulsions, rubberized asphalts, and mineral-filled asphalts can all be compared on an equal basis. Viscosity in poises measured at some fixed rate of shear supplies the common basis for comparison.

Two or three types of viscometers now available make possible the evaluation of consistencies ranging from 0.01 poise (the viscosity of water) to about 10 billion poises. The best apparatus known by the author for measuring consistencies up to about 200 poises is one of the reverse-flow-type viscometers recommended by the ASTM for use with opaque liquids. Reference to and illustrations of these instruments may be found in "Tentative Method of Test for Kinematic Viscosity," ASTM D 445-53T, Appendices B and G. ASTM Standards Part 7, 212 and 226 (1958).

Higher viscosities can be determined in several different viscometers. One of the most modern types, the microfilm viscometer, with its auxiliary equipment, is shown in Figure 1. The viscometer is pictured alone in Figure 2. A uniform film of asphalt about 25 microns (1/1000 inch) thick is placed between two glass plates measuring three by two centimeters. The exact thickness of the asphalt film is determined from its weight and surface area (six square centimeters). The plates are inserted in the viscometer where one is held firmly in place and the other is moved by application of a weight. The plate is moved a very short distance. The weight required to cause a particular rate of movement depends on the viscosity of the asphalt. A few grams may be sufficient for a soft asphalt but several thousand grams may be required if a hard asphalt is being investigated. The movement of the plate for a given period of time is recorded on a chart. Knowing the weight applied and the rate of movement of the plate, it is possible to calculate in poises the viscosity of the thin film of asphalt. To avoid complications that may arise, especially with hard asphalts, the viscosities are always reported at the same rate of shear. A number of determinations may be made by one operator in a working day. It should be pointed out that viscosities obtained with the thin-film viscometer check with values obtained by other types of apparatus not discussed in this brief presentation.

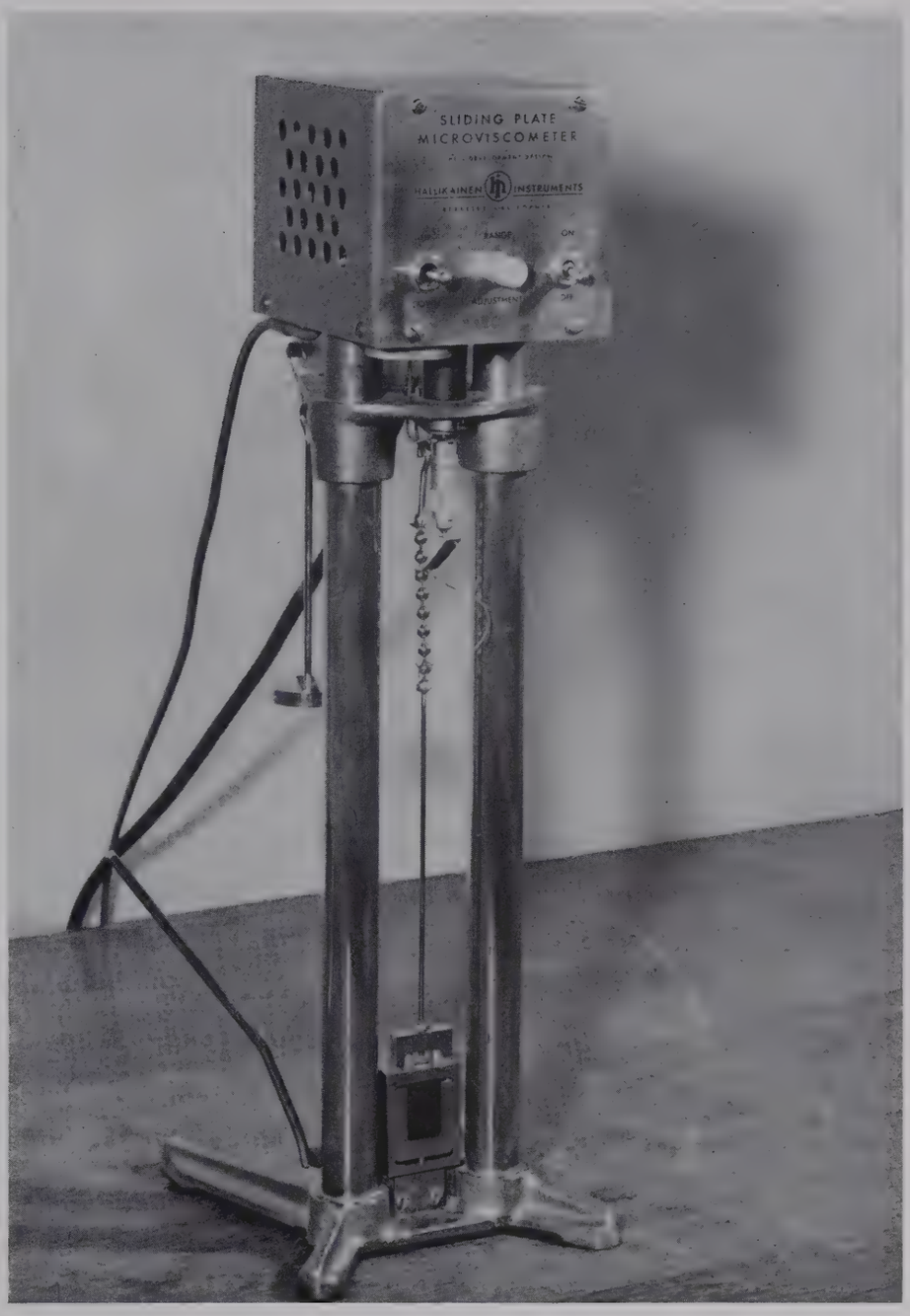


Figure 2—Microfilm viscometer.

Table I shows data on road-building asphalts made by ten different manufacturers. All are 85-100 penetration asphalts (OA-90) and the penetrations varied from 89 to 98 at 77°F/100 gms/5 secs. The viscosity

values which were obtained by the thin film method vary from 700,000 to 1,300,000 poises at 77°F. It should be noted that Asphalt A with the hardest penetration (89) and almost the highest softening point (118°F) has the lowest viscosity at 77°F. Asphalt E with the softest penetration (98) and a fairly high softening point (116°) has a viscosity just below the average. Asphalt J which has about average penetration (93) and a high softening point (117°) has the highest viscosity (1.3×10^6 poises). Among the group of ten asphalts there is a spread of nine points in penetration, 8°F in softening point, and 600,000 poises at 77°F. Data similar to that given in Table I have been obtained by numerous investigators during the past two decades, and the conclusion is firmly established that consistency measurements in absolute units are more sensitive, precise, discriminatory, and informative than the penetration test.

The importance of the consistency at mixing temperatures has been mentioned. Table II again lists the ten asphalts and gives the penetrations at 77°F and the viscosity in poises at 280°F. Asphalts E (98 penetrations) and A (89 penetrations), which are the softest and hardest on the basis of penetration, both have about the same viscosity in poises at 280°F. The asphalts possessing low viscosities at this operating temperature have about average penetration values. The penetrations at 77°F show a range of about 10 per cent, but the viscosities at 280°F extend over a range of 80 per cent. It is evident that the penetration test cannot be used to obtain an idea of the consistency of an asphalt at normal handling and mixing temperatures. Absolute viscosity data are again more precise and discriminatory.

We must now consider another complication encountered during the complete and satisfactory evaluation of the consistency and flow properties of asphalt at service temperatures. This is the presence of internal structure in the asphalt which results in the appearance of complex or non-Newtonian flow. When an asphalt possesses any appreciable amount of internal structure an applied force tends to cause breakdown of the structure with a decrease in the measured viscosity. As the force is increased the measured viscosity decreases. Thus, the amount of structure present in an asphalt may be evaluated by measuring the viscosity at different shearing stresses (applied forces) or different rates of shear. Such information aids in understanding the behavior of asphalts under service conditions because all asphalts, with the passage of time and under service conditions, tend to deviate from simple viscous flow. The rate at which structure builds up in an asphalt is closely connected with its durability as a binder. An ideal material would show little or no hardening and slight change in complex flow with time.

The important point here is that the degree of complex flow present in an asphalt cannot be satisfactorily evaluated by the penetration test but can be measured in the proper type of viscometer. For evaluation of complex flow the viscosity is measured at three different rates of shear. The viscosity values are plotted against rate of shear, and the change in viscosity for a given change in rate of shear is calculated. When no change in viscosity occurs with change in rate of shear, the asphalt is essentially a viscous liquid. But, if a decrease in viscosity occurs when the rate of shear is increased, the asphalt possesses in-

Table I

Penetration and Viscosity at 77°F For OA-90 Asphalts

Sample	ASTM Pen. at 77°F	Softening Point B&R °F	Viscosity at 77°F Million of Poises*
A	89	118	0.70
B	93	115	0.80
C	94	117	0.80
D	90	115	0.85
E	98	116	0.90
F	92	111	0.90
G	92	119	1.00
H	92	117	1.10
I	90	117	1.20
J	93	117	1.30

*Calculated at a rate of shear of 5×10^{-2} reciprocal seconds.

Table II

Penetration at 77°F and Viscosity at 280°F for OA-90 Asphalts

Sample	ASTM Pen. at 77°F	Viscosity at 280°F poises
E	98	3.6
A	89	3.5
B	93	3.5
I	90	3.3
G	92	3.0
J	93	3.0
F	92	2.3
H	92	2.3
D	90	2.0
C	94	1.9

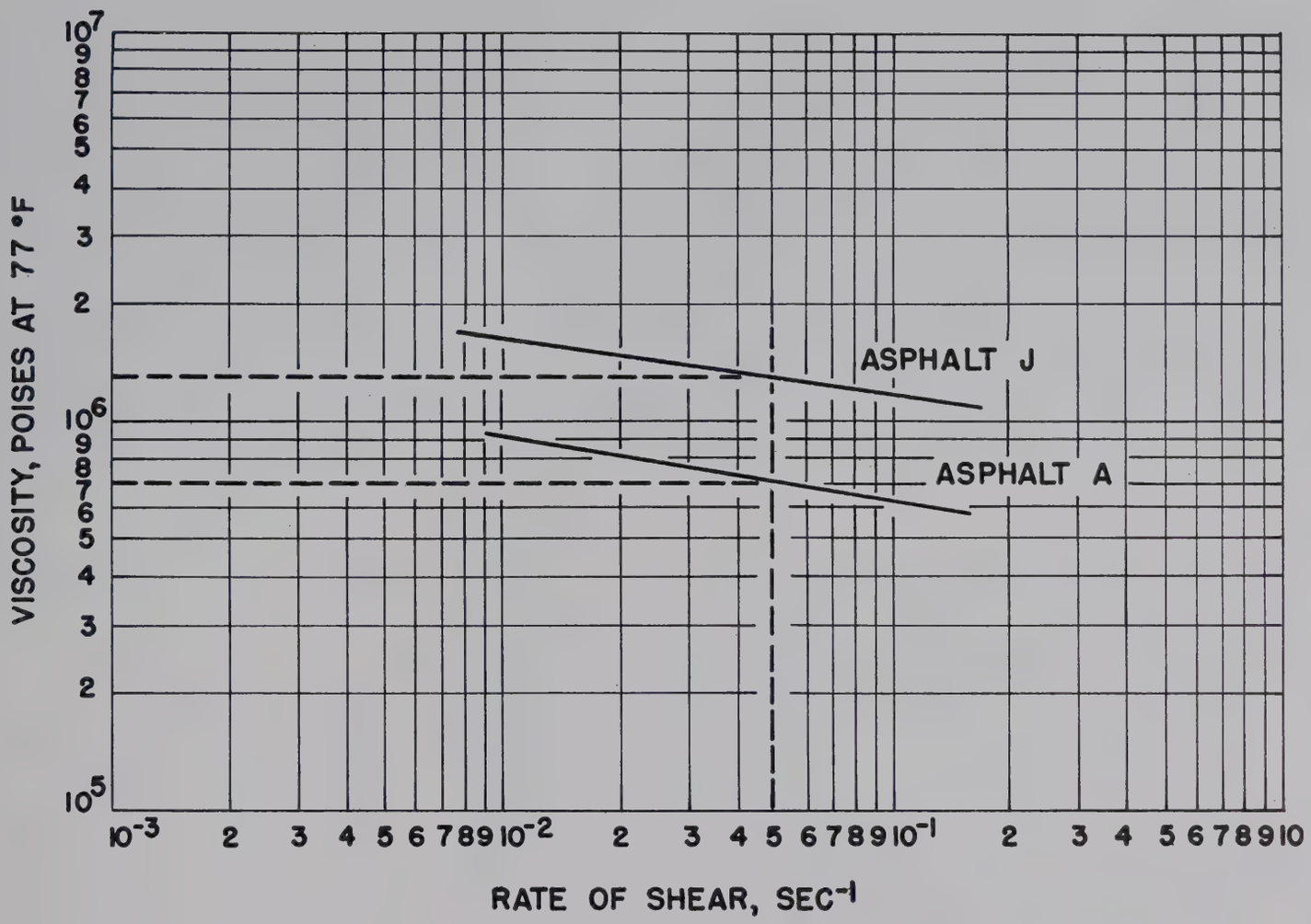


Figure 3—Absolute viscosities calculated at 5 x 10^{-2} reciprocal seconds.

ternal structure, and the amount is reflected by the change in viscosity. Also, to compare the viscosities of materials possessing complex flow, three experimentally determined viscosities for each material are plotted against rate of shear and the viscosity of each asphalt is calculated at a common rate of shear. Figure 3 is a log-log plot of the experimental data obtained for asphalts A and J at 77°F. The viscosity of each asphalt was determined at three different rates of shear. Each viscosity value was plotted against the rate of shear used in its determination. Since duplicate samples were tested, six values were used in obtaining the line shown for each asphalt. Figure 3 shows how the viscosity values for A and J were evaluated at a shear rate of 5 x 10^{-2} reciprocal seconds. These average viscosities at a common rate of shear are the values shown in Table I.

The facts presented above lead to the conclusion that empirical methods, such as the penetration and softening-point tests, for evaluating consistency have serious limitations. These methods are not sufficiently sensitive and are incapable of detecting important differences that may exist in the consistency and flow properties of paving-grade asphalts. These undetected differences may be responsible to a considerable extent for the success or failure of an asphalt in service. The asphalt technologist should know the consistency characteristics of the asphalt being used in a particular installation, and he should use the most precise and informative procedure for obtaining the necessary data. This requirement points to the use of an absolute viscometer.

Familiarity with the usefulness of absolute viscosity data at operating and service temperatures is increasing rapidly. Such understanding will eventually bring about general acceptance. The struggle for recognition of the viscometer as a working tool for the asphalt technologist seems to have reached a climax. Every reader of this brief discussion should give serious thought to the possibilities for advancing bituminous technology through exact evaluation of consistency.

The next article will discuss the susceptibility of different asphalts to hardening by oxidation. It will be shown how absolute viscosity measurements detect differences in hardening that cannot be detected by the tests generally employed at present.

One brush is in action here, cleaning the top of the curb.

Sixteen-inch disc used for edging.

Employees of District 14 have developed a tractor-mounted brush for cleaning concrete curbs in preparation for painting. This brush was developed by J. K. Nash, Senior Equipment Supervisor; Carl M. Nowlin, Equipment Supervisor; and Frank Marx, Eugene Volz, Bill Bates, and other employees of our shop.

The equipment consists of a tractor to which has been attached an A-frame from a maintainer, and hydraulic lifts and air grinder with a six-inch steel brush. The brush is attached to the A-frame, controlled by the hydraulic lift, so that it can be adjusted to fit the curb being cleaned. The brush is protected by a guard made of belting or similar material. A second brush, for cleaning the vertical face of the curb, may be attached to the A-frame, with air from the second nozzle on the small air tank. Air is furnished by a 125-cubic-foot air compressor, trailer mounted.

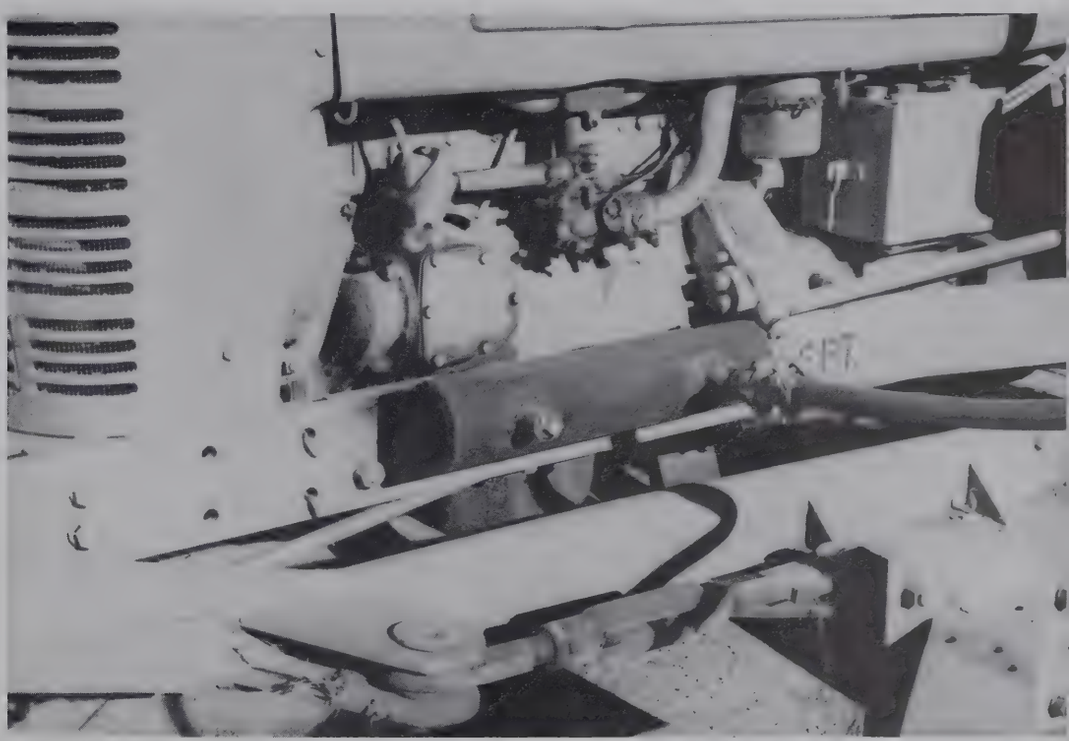
On the Austin Expressway, the brush cleaned 23,500 linear feet of curbing in approximately four and one-half hours. The brush was worn out at that time.

Another attachment to this piece of equipment is a sixteen-inch disc mounted on a spindle and hub for edging grass along the curb. The hub has been built up to approximately seven-and-one-half-inch diameter to give more stiffness to the comparatively light disc. This attachment is mounted on the A-frame and is also controlled by the hydraulic lift. It is a modification of equipment developed by District 15.

Curb Brush

J. M. Owens, Assistant District Engineer
District 14

A brush used for cleaning curbs prior to painting can be seen, covered by a guard, on the side of this tractor.



Air connection for the brush. The plugged connection is for the second brush.

Protecting the brush when it is not in use is this guard, made from belting or similar material.

WAREH

OUSE : Reorganized and Systemized

Floyd F. Guerrero, Warehouse Superintendent
District 12

In November of last year, the Houston district installed a system of storage and material handling relatively new to district warehouses. The system revolves around two basic pieces of equipment—the fork-lift truck and the pallet. All materials which can be stored on pallet racks, handled on pallets, and moved by fork-lift truck have been concentrated in one room —which now houses approximately one-third of the total volume of materials dollarwise in the entire warehouse. The turnover in this section is consistently much greater than in the rest of the warehouse.

The rapidly increasing workload demanded that we reorganize our warehouse, presently first in the State in total dollar-volume of material handled. In 1958-1959, the figure was $1,700,000. A study was made of operations of firms using the fork lift and, impressed by the economy, efficiency, and ease of operations, we decided to convert to a similar system.

The advantages have been manifold. Large pieces of machinery or drums of liquid can be handled easily, preventing possible injury to employees and eliminating damage to stock caused by dropping. The use of these pallet racks permits unlike or irregularly shaped pallet loads to be stored one above the other, saving floor space. The ability of the fork-lift truck to stack materials at greater heights in effect doubles the capacity of the warehouse for many types of materials.

In connection with our warehouse operations, the District has its own 35-foot trailer to transport materials purchased from the General Warehouses. Although the initial outlay for the trailer was $4,100, it will soon have paid for itself in savings on freight costs. Most of the items picked up at the General Warehouses are palletized. This permits loading and unloading of the trailer by one man with a fork-lift truck.

The time required by employees to load and unload materials has been cut drastically. Every two weeks approximately 3,000 gallons of paint in five-gallon buckets weighing 65 to 70 pounds arrive at the dock. Formerly these had to be stacked by hand several buckets high, taking four men four to five hours. It now takes one man just one hour to unload the van and store the paint.

A time-consuming job has always been the wrapping and storing of signs in a manner to prevent marring or damage. As a run of signs was completed in the shop, signs were individually separated in sheets of wrapping paper, stacked on flat hand trucks, and wheeled to the warehouse to be placed in racks by hand. This six-to eight-hour job can be accomplished now in less than an hour, using slotted pallets which do away with the necessity of placing paper between signs. Signs are now placed in these slotted pallets as they are finished in the sign shop. The fork truck picks them up, ready for storage in the warehouse. Damage to signs is nil, and storage space has been reduced by one-third. We average one sign run each week at around 250 signs per run.

The use of pallets and fork-lift truck has done away with one of the most plaguing problems in our warehouse—that of dust in handling cement. Under the new setup, sacks are stationary on pallets during all handling inside the warehouse, therefore, there is no dust raised. Aside from elimination of the dust problem, the palletizing of cement and the handling with fork-lift truck makes pos-

Donald Williams, Skilled Laborer, drives a pallet loaded with sacks of cement through the warehouse in Houston, raising no dust in the process.

Warehouse Superintendent Floyd Guerrero loads a heavy compressor onto a truck at the warehouse loading dock.

sible the unloading of two thousand sacks of cement by twelve men in four hours. Previously, this was a job which took twelve men nine hours to do. Also, equipment-rental time on the two dump trucks used has been cut five hours on this job, thus increasing the saving in cost.

Figures indicate that in the period from October 30, 1959, to December

Fettes and Guerrero inventory signs stored in special slotted pallets. This storage makes inventory a simple matter.

4, 1959—approximately a month and a half—a total saving of 344 man-hours was realized. In money, the total was $1,379, which includes savings made on freight by use of the trailer.

The fork-lift truck was obtained from the Athens General Warehouse. It had been in use for more than two years, so the depreciated cost to District 12 was $1,480. The cost of the same fork lift new would be about

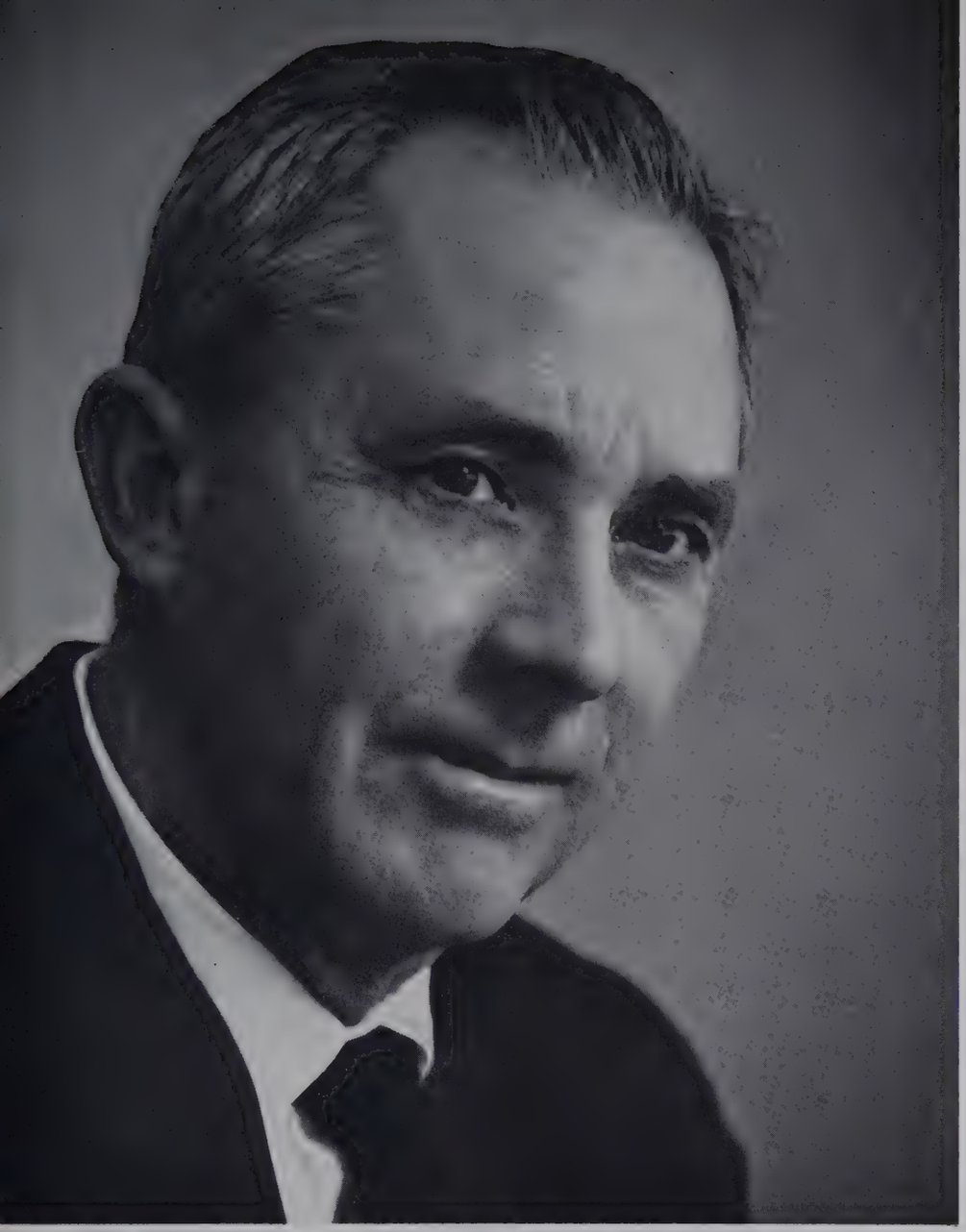
When a sign is needed, the fork-lift truck lowers a pallet. The requested sign is removed and the pallet replaced—no time lost and little energy expended. Owens removes a sign here to be sent to the field and installed.

Lawrence Miran and Jerry Owens, Skilled Laborers, handle stock manually in a section of the District 12 Warehouse not yet converted to fork-lift operations.

$3,900. Cost of the pallets was $626.40, and pallet racks cost $1,132.

Inventory work has been simplified by this new materials-handling system. Pallets sections are numbered to conform to bin section and bay numbering in use elsewhere. The traveling field auditors of the Accounting Division, and Gene Cuenod of Equipment and Procurement Division assisted in setting up this system.

Edward Ottis, Junior Inspector, removes surveyor's stakes from a truck and places them on a pallet. Owens drives the fork-lift truck.



George Carver

Carver New D-10 Head

Long-time Highway Department employee H. P. Stockton Jr. died on January 10. Planning Survey Division head since 1950, the 63-year-old Stockton had 38.94 years with the Department.

A graduate of Texas A & M College, Stockton started with the Department in 1919 as a Field Engineer in Ellis County. At one time—from November of 1928 to February of 1932—he served as Division Engineer in District 15. From February of 1932 until December of 1935, Stockton was in Austin as Assistant to the State Highway Engineer.

In Austin, the Highway Commission paid tribute to Stockton at the January hearing, passing a minute order expressing the appreciation of all his associates for his efficient, loyal, and faithful discharge of his duties.

Replacing Stockton as Engineer of Planning Survey is George Carver, formerly Assistant Planning Survey Engineer. Carver has been with Planning Survey Division since its creation as Highway Planning Survey Division in 1936.

Born in Wetmore, Bexar County, Carver attended A & M College and The University of Texas. His work with the Department began 34 years ago in Bexar County. His tenure of duty includes four years as Assistant District Engineer in the Lubbock District.

His first assignment in Planning Survey in 1936 was to organize a mapping section. He headed this section as Chief Cartographer.

A member of the Vestry of All Saints' Episcopal Church, Carver is married and has two grown children. He has served as state president of Texas Public Employees Association, and has also been president of local Chapter 1.

CONSTRUCTION STAKING

Robert L. Lewis, Senior Designing Engineer
Highway Design Division

The staking of complicated intersections and expressway geometrics has been a real problem that many engineers have encountered in the expansion of the modern highway system. This is especially true where physical features, obstructions, and traffic congestion prevent laying out reference lines or centerlines in the field for design and construction.

In Austin, Interstate Highway 35 from Nineteenth Street to the Colorado River follows old East Avenue. Approximately 30,000 vehicles each day now use the existing facility with heavy traffic congestion at all the cross streets. The terrain here is rough, sight distance is poor, and there are virtually no alternate routes available to detour traffic. This made reference-line staking a real hazard to field personnel. Chaining was almost an impossibility.

In the initial stage of development, the old monument line for East Avenue was established as a base line. This, with the aid of traverses, was used to prepare a stadia contour and topographic map for design studies and schematic layouts. Supplementing this with recorded subdivision plats, a right of way map was prepared. It was soon apparent that this type of control was inadequate for detail design and construction control.

A study of the various programs available from the Computer Section of the Operations Division indicated that coordinates could be easily obtained for any predetermined point within the project. With some small changes in one of the Bridge Division Programs, additional information could be secured to simplify staking these points in the field.

From the approved project schematic, reference lines were developed for each component roadway. The interdependent traverse program was used to calculate, tie together, and check the various lines. These traverses were oriented and tied to the Texas Coordinate System.

The B-10 program computes the coordinates when the station and offset are given or the station and offset with respect to a given reference line when coordinates are furnished. This B-10 program was therefore used to obtain coordinates for each reference line station, P. C., P. T., P. O. T., and for each desired plus station. Coordinates were also wanted for several reference points at right angles to the project reference line. This was needed to establish cross-section lines and construction hub points.

A separate B-10 was submitted to determine coordinates of all other points that might be needed during construction of the project. All dominant points required to stake ramps, connections, turnouts and transitions were listed. Since traverse programs were used initially to calculate the geometrics involved, the coordinates of these points were readily available to use in the B-10 submission.

The output information for all these predetermined points as submitted on the B-10 was listed and then stored for future use. The listed data from the B-10 was very helpful in plotting the various layouts required in plan preparation. The B-10A was submitted to obtain the profile grade elevations on the reference lines at zero offset. The stored data from these B-10 problems was used later with other computer programs to develop design sections in the earthwork computations.

With the coordinates available for all the points desired for design and construction, a method was now needed to set these points in the field. To establish terminology they were designated as Station Points. These station points could conceivably be set in the field if they could be "cut in" from two major control points. In other words, the station point would

become the intersection point of two lines whose bearings could be calculated.

The Bridge Division's B-11 program was the answer to our needs. The program calculates the distance and bearing between two given points. To this program was added the feature that permits the computation of angles necessary for construction staking. This program is now known as the B-11 A and B.

Permanent markers set in concrete and known as control points (on sketch, Points 1, 2, and 3) were then set along each side of the project about one block apart. These primary

BY TRIANGULATION

Editor's Note: Mr. Lewis was with District 14 at the time this article was written.

control points were designated with a number and set so that they could command a view over the project area. Each station point (on sketch, Point A) must be within view of at least two and preferably three control points. Each control point was set so that a known reference point could be observed. Since coordinates for the star on the Capitol dome were available, this provided an excellent reference point for most of the control points. Any point whose coordinates are known and can be seen from the control point may be used as a reference point.

Triangulation and traverse methods were used to determine accurately the coordinates for each control point.

A submission was made on the B-11 A and B problem for each control point. The coordinates for the control point and the reference point, together with the appropriate B-10 problem for the stored station points, were submitted as input.

The output listing from the B-11 A and B provided the distance and bearing from the control point to each station point and the clockwise angle from the reference point to each station point (see sketch). With this information available, it was possible to set any one of the preselected station points on the ground without having to do any field calculations.

A strip map was prepared to show each station point and control point. Each station point was assigned an identifying number corresponding to the line number on the B-10. The B-11 A and B also carried this number. Thus the data for any one point could be readily found.

Two Kern theodolites were used in the field to establish control for cross sectioning. (The theodolite reads directly the clockwise angle and only that angle when zero angle is observed on the reference point. This establishes a simple pattern and reduces mistakes in turning angles.)

With an instrument on each of two control points commanding the area, the party chief called a station point by number. Each instrumentman using the data for his respective control point turned the indicated angle to the station point. A rodman with a little practice soon was able to find the point of intersection rapidly and set the station point. Control for approximately 70,000 linear feet of cross sections was staked in one week, under adverse traffic conditions, without staking a centerline or having to chain across moving traffic lanes.

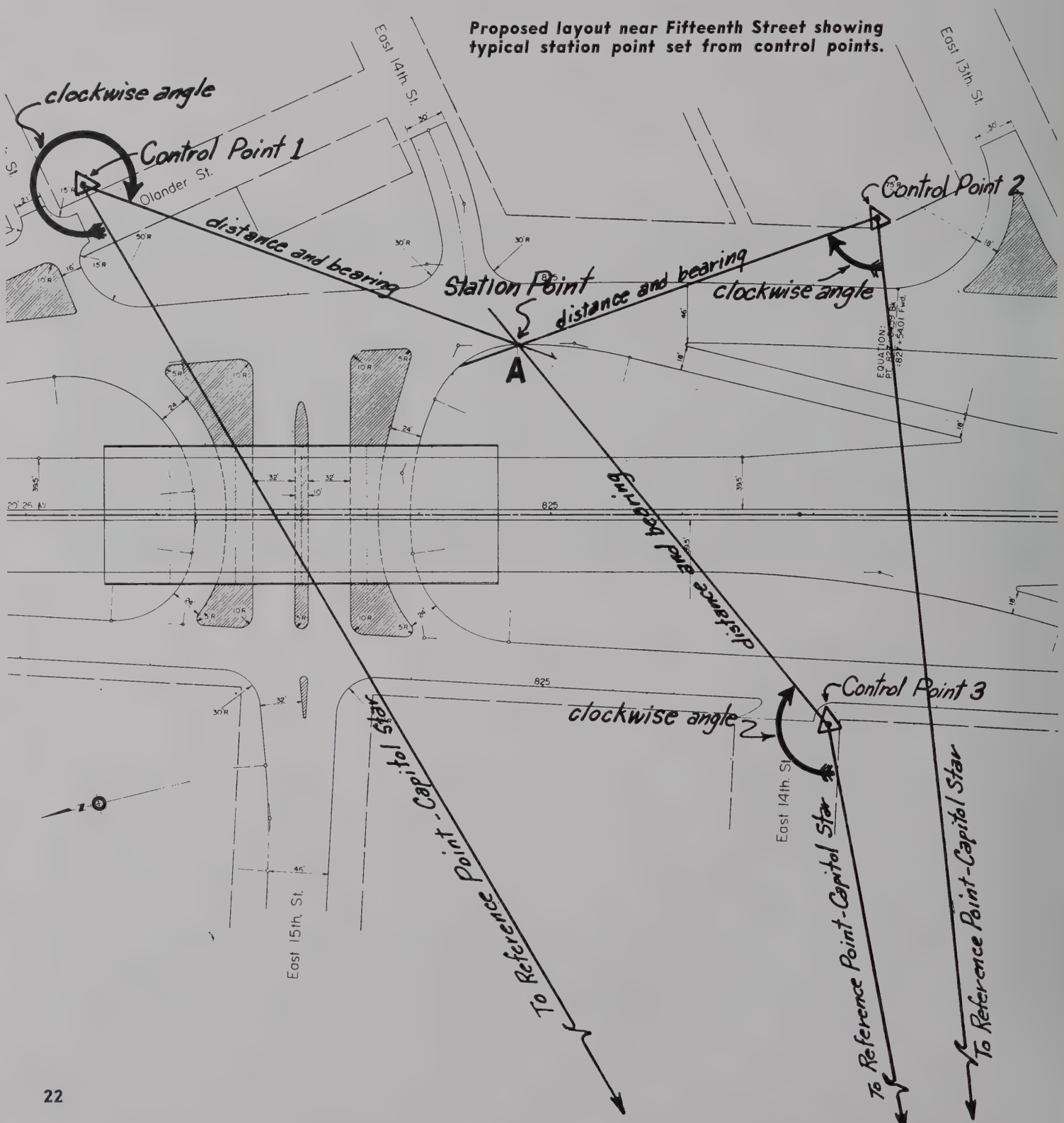
Communications between the party chief and the two instrumentmen were accomplished by hand signals. However, during construction staking two-way hand radio units will be employed.

Utility adjustments are now being made on this project and the locations of these are being set from control points. Curb lines, radius points, bridge columns, and major construction points can be set on short notice without having to do a lot of preliminary work.

How accurately can the station points be set? That depends, of course, upon how accurately the control points are set and upon how ac-

curately the horizontal angles can be turned. A short foresight (500 feet or less) will minimize the error resulting from the angular error. The provided angular calculations are given to the one hundredth of a second. We believe that angles can be consistently turned to within five seconds of the desired angle. Several station points have been set from two control points (Points 1 and 2) and checked from a third control point (Point 3). The usual variation is less than five-hundredths of a foot. Strong angles of intersection, of course, are desired.

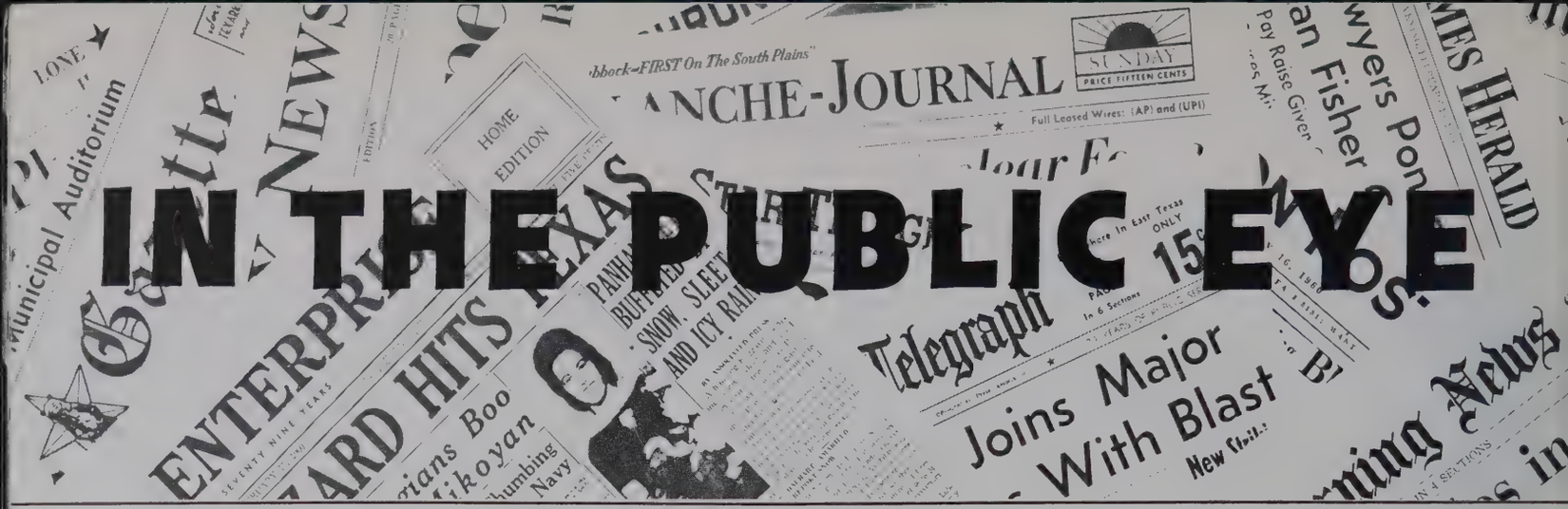
This method of staking could very well be the answer to staking complicated intersections containing numerous compound curves, small radius curves, islands, and construction features that are normally difficult to stake. Since reference lines are maintained, it is not necessary to completely replace the conventional methods of staking with triangulation staking. They can be worked together. There may be stages during construction or portions of the project where reference lines may be more desirable and convenient to use.



Proposed layout near Fifteenth Street showing typical station point set from control points.

Looking north along East Avenue from Fifth Street, clearance along the right of way can be observed.

This view looks south from Fifth Street on the extension of East Avenue.



IN THE PUBLIC EYE

THE SAFE SIDE

Amarillo Daily News, from its daily column "A to Izzard"—"The new concept likely to emerge in the 1960s will be based on engineering as applied to streets, highways, and the automobiles themselves. . . . More and more traffic safety is becoming a problem of engineering."

Beaumont Enterprise, reporting on a speech made by D. C. Greer—"He called the interstate highway system 'the greatest safety program ever undertaken,' describing the limited-access freeways as 'the safest highways that can be built.'

" 'It has been estimated that completion of the interstate system will save one life annually for each ten miles. This will mean 300 lives saved each year in Texas,' Greer said."

THE WHY AND WHEREFORE

San Antonio Light, quoted W. C. Raby, Construction Engineer for District 15, in an article about IH 35—"The freeway incorporates all of the latest beauty and safety features, including a chain-link fence to keep pedestrians from crossing the high-speed freeway lanes."

Houston Chronicle, remarking on good engineering management in explanation of a puzzling sight—"Persons who have been in the vicinity of the Capitol Avenue Bridge in recent months will have noted a second high-level overpass, topping both the bridge and the Texas-Prairie twin overpasses, and wondered about it since it was obviously not connected to anything. . . . The overpass crossing . . . was built at this time because construction crews were working there anyway, and it was decided, wisely, to do the whole job in that area at one time instead of returning at a later date and disrupting traffic again."

Beaumont Enterprise, from a speech made in Austin by D. C. Greer, State Highway Engineer—"Multilane highways, which have grown from 63 miles in 1955 to 2,168 at present, will total 5,500 miles [by 1975]. Expressways carry three to four times as much traffic as standard highways of the same width and are about three times as safe."

Fort Worth Star-Telegram, using Greer's above-mentioned comments as a springboard for an editorial—"Even on the best-engineered of highways, of course, motorists can still manage to kill themselves or others. The job of engineers is to minimize as far as possible the human factor in highway accidents. They are making notable progress, but there is a point beyond which they cannot go. It is to be hoped that driver discipline, either self-imposed or enforced by authority, will increasingly take over at this point."

Houston Chronicle, in an interview with Houston's District Engineer—" 'A multilane service road is often the first stage of a full freeway,' [Wiley E.] Carmichael explained. 'It may take the full ten years to have a full freeway to Hempstead,' said Carmichael. 'We try to build the freeways where the traffic is the heaviest and the need the greatest. Our way of looking at it is, if it carries the traffic, we'll improve it to top standards.' "

Dallas Morning News, from its Washington Bureau, quoted Democratic Representative John Blatnik of Minnesota whose public works subcommittee was named to investigate excessive costs in the highway program—"A question was raised . . . about proposals to require 17-foot bridge clearances on the Interstate system, rather than the 14-foot standard, and whether highway users should pay these added costs brought about by defense needs. Blatnik stated that his special subcommittee will look into this, and that if he had his way, the Defense Department would be charged the entire cost of bridges with higher clearances."

ON COURSE

Austin American, reporting State Highway Engineer D. C. Greer's remarks at year's beginning about building progress on this state's highways—" 'The interstate system is less than four years old, and yet we are at some stage of programing, constructing, or completion on all but 18 per cent of the 3,033 miles assigned to us to build.' "

Houston Chronicle, telling the result of a meeting of the State Highway Commission and a delegation seeking to expedite construction of a Rio Grande Valley expressway—"Greer said his office felt the economic thing to do on the project was to push right-of-way acquisition to completion, then build the parallel frontage roads, then go back and build the entire expressway section by section in its entirety. The expressway would run from west of Mission in Hidalgo County to Harlingen in Cameron County."

Quotes from Texas newspapers give Texas Highways readers a capsule review of highways in the news.

UPS AND DOWNS

San Angelo Standard-Times, interviewing R. N. (Al) Jennings, Maintenance Engineer of District 7, when the Department replaced former truck-load limit signs with the higher 72,000-pound notices—"'We have given as much freedom as possible to the new load limits, but many of our roads and bridges just won't take the heavier loads.' In [this] District there are only nine bridges over which the engineer believes the heavier loads would be unsafe. Those will be marked with special weight-limit signs."

CARRYING THE DAY

Corpus Christi Caller, by editorial, approved the State Supreme Court ruling that state and federal funds, not those of cities and private corporations, should pay for relocation of utility lines along interstate highway projects—"The Legislature may later look into the question of rental to the state for utility lines located on state-owned right of way. But that is another issue, though it was interjected as an excuse for opposing relocation reimbursement."

Dallas Morning News, on the Court's opinion, editorialized: "Customers of the city water system and private utilities will benefit. In the long run they would face the possibility of higher utility rates if utilities had been forced to shoulder this large item of expense. But as state and federal taxpayers, virtually all of these same customers will still bear their part of these costs. There is no gift involved; only a question of which pocket it will come from."

AT VARIANCE

Austin American, excerpts from a wire story datelined Washington—"Administration officials are reported to have been unhappy because many states have concentrated first attention on the urban routes. . . . The city links are by far the most expensive parts of the system because of the high cost of rights-of-way and the difficulties of building cloverleafs and other access roads in congested areas."

Corpus Christi Caller, by editorial—"Texas cities are mainly dependent on property taxation for street funds, and that source simply could not carry the cost of expressway programs. . . . Urban expressways are expensive, but they are an integral part of the proposed national highway network and should be financed like the rest of it. The administration would be well advised not to recommend any change detrimental to municipalities."

THE FUTURE IN IT

Fort Worth Star-Telegram, quoting District Engineer R. A. Bossy—". . . Bossy noted that experience has shown that real estate values usually show a sharp rise in the vicinity of freeways and new highways. Most developers, he said, are particularly conscious in their planning of arterial highway planning and patterns. . . . This overall progress in highway planning and construction, he added, places Fort Worth in an extremely favorable position to attract new industries, especially those requiring modern highway facilities."

TO MARKET, TO MARKET

Beaumont Enterprise, from a speech on the subject of highway expansion made by State Highway Engineer D. C. Greer to an Austin luncheon club—"He said the present 60,000 miles probably will grow to around 70,000 by 1975, largely as a result of additions to the farm to market road program."

San Angelo Standard-Times inventoried highway construction prospects for District 7 in these words: "With a multi-million-dollar program of first-line highways completed or under construction and federal aid money prospects limited, the San Angelo district is booked for a high ratio of farm and ranch to market road construction the next year or so."

WAYS AND MEANS

Dallas Morning News, in an editorial titled, "Gasoline Camel, Last Straw"—"Directors of the Texas Good Roads Association meeting in Austin expressed concern over the possibility of the next Legislature boosting gasoline taxes for the benefit of public schools. . . . If the gasoline tax is to be increased and diverted from its usual application to road construction and maintenance, then probably no worthier cause than support of education could be found. But we have come to the limit of taxing the gasoline consumer for both federal and state funds. . . . Any new gasoline tax levied in Texas will go in the amount of one fourth of the levy to public schools. This is true of the present levy, and because of it, Texas is among the leading states in the amount of gasoline tax that is diverted from highway building."

Houston Chronicle—"One way to soften objections to higher gasoline and vehicle taxes is to earmark the tax for highway construction. A major objection raised by oilmen last year to the one-cent a gallon boost in the federal gasoline tax was the amount of motorist's taxes already going into the general fund. Such objections will be renewed this year if the anticipated efforts to boost the federal gasoline tax another half cent or more actually develops. The American Petroleum Institute contends only 38 per cent of all the federal government's special taxes on motorists for the fiscal year ending June 30, 1958, went into the highway fund."

Dallas Morning News, by editorial—"The consumer of gasoline is relatively just about the most heavily oppressed taxpayer in America. The theory behind this heavy taxation is that the money is used to build and maintain roads for the use of the gasoline consumer. Any additional taxes should live up to the theory. At present, neither federal nor state taxes do so."

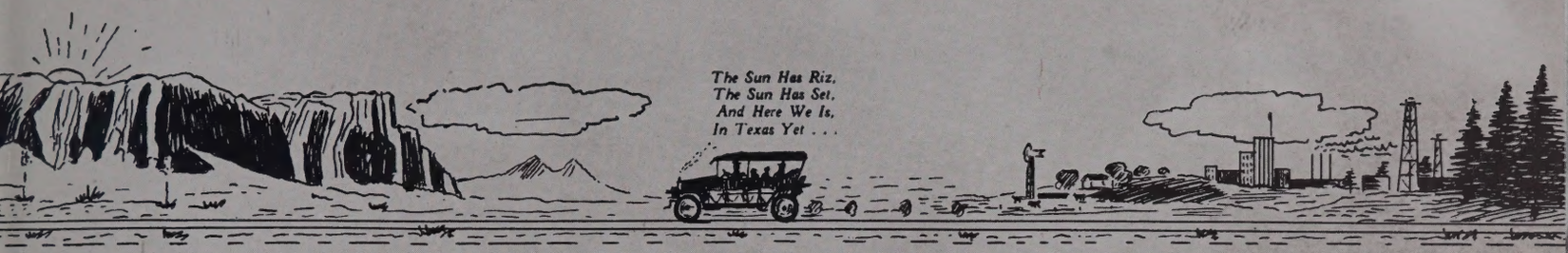
The protector has proven to be a timesaver as well as a money saver.

Headlight Protector

Walter E. Ruff, Senior Resident Engineer
District 9

During the first week of the 1959 Seal-Coat Program for District 9, a costly problem was facing the Department in the continuous breaking of headlights of State equipment by flying topping aggregate. Not only was it expensive and time consuming to replace the headlight units, but it also created a traffic hazard to the traveling public in that the inspectors were required to do considerable night driving between projects. One-quarter-inch mesh hardware cloth was fastened to the grills of the two State pickups used on the projects with bailing wire, ending the breakage problem. Total cost of this safety device was approximately $1.50, as compared to the recurring cost of replacing headlight units at 94 cents each.

Seal coat job inspectors Byron R. Wilkinson, Senior Engineering Assistant, and Charles B. Hinton Jr., Inspector, install one of the protective devices.



OVER THE HIGHWAYS

Comments . . . from the Traveling Public

• Many times have I left Texas, either on a business trip or for pleasure, and each trip away from Texas convinces me all the more that "be it ever so humble" there is no state like the great state of Texas.

Of course there are many and varied reasons why my family and I feel this way about Texas. As Texans, we are indeed proud of our home state, our people, and the many accomplishments of this great state, but there is one reason in particular why we are always glad and happy to return to Texas, no matter how pleasant a trip and how good the times we had out of Texas. The reason lies in the wonderful highway system of Texas.

Therein lies the reason for this letter. We know that this wonderful blessing of the State of Texas is not the end result of any one person, but the accumulated efforts of all the people involved in engineering, building, maintaining, and patroling its wonderful highways and byways. How do you tell all these people what a wonderful job they are doing? How do you thank them for their hard work, and for a job well done? We wish that we could personally tell each and every one of them how much we appreciate the good use to which they have put our tax dollars. Of course we know that we cannot tell each of them personally but we hope to at least convey our thoughts to some of those who are responsible.

It is indeed a privilege and a blessing to ride and drive on the Texas highways. Perhaps most Texans are not aware of this unless they have the opportunity to compare the highways of other states and yes, other countries. The road signs, the highway numbers, the mileage and distance distance markers are plentiful and plainly marked. Unless you have traveled in other states you cannot possibly appreciate this factor. The roads and right of ways are, for the most part, wide and remarkably smooth. But the thing that really impresses the traveler, be he native or from out of state, is the way the highway right of ways are maintained. How free they are of weeds, tall grass, scrub brush, and litter, compared to any other state you may choose to travel in. Last but by no means least, are the most wonderful roadside parks that are provided for the highway traveler by the Texas Highway Department. These little parks are oases and a joy to any traveler. They are well kept and maintained and certainly a credit to, and silent ambassadors of good will for, the State of Texas.

B. G. Eastman
Austin, Texas

• **Excerpts from a taxpayer . . .**

January 8, 1960

. . . At the northeast corner of our property, there is a culvert under the road. Prior to the time the present culvert was installed, heavy rainfall did not do much damage. The present culvert jets the water in such a concentrated stream that extraordinary force of it has dug an unusually deep ditch. . . . A news report stated that work was scheduled to improve this highway in the near future. I would be grateful if, during the process of improving the road, I could get together with your engineers on a project to repair past damage and to work out a design that will prevent it in the future.

I have had no experience in dealing with your department. Will you please advise me what to do to accomplish the desired results.

G. B. Coleman
Houston, Texas

January 26, 1960

• This is a response to the letter you wrote on January 18 in answer to my letter of January 8 to your Austin office about erosion on my place.

It is most gratifying to have had such prompt attention to the matter. I realize that your department has considerable work scheduled and, accordingly, appreciate your speedy action.

. . . Thanks again for your promptness. I didn't know such a busy department could get around to such things so quickly.

G. B. Coleman
Houston, Texas

To and From Our Readers

LANDSCAPING magazine for December carries an article stating, "You can tell the difference in Texas highways from the moment you cross the state line. They are, for one thing, distinguished by outstanding landscaping by comparison to most other states, also have fine engineering quality, good sign markings, etc. . . ."

In answer to questions concerning the roadside park in the display on page 22 of the January issue, the park *is* the Leo Ehlinger Roadside Park. It is located on the western edge of Brownwood, and overlooks the city. Ben Lednicky wrote in identifying and asking if he was correct. A check with Humble showed that he knew his roadside park.

This year's Highway Short Course will be held March 8, 9, and 10 at A & M College. The meeting of District Engineers, Division Heads, and Engineer-Manager will begin at 10:30 Monday morning, March 7, at the Memorial Center.

"HES TRYING TO MAKE US THINK ITS ANOTHER RUSH JOB."

About Our Pictures . . .

Utility adjustment figures prominently in the roadbuilding program underway in Texas. For latest developments, see story an page 2.

Sewer-line relocation on Interstate 35 in Austin is the subject of Photographer Bob Gates' cover picture this month.

Construction pictures often have artistic beauty. The concrete beams of a structure on Interstate 35E north of Dallas provide the study in contrast inside our front cover.

Concrete and steel blend into the setting of sky, clouds, and greenery as if provided to complement nature's furnishings in this picture inside the back cover of the Industrial Boulevard Overpass on Interstate 35E in Dallas.

TEXAS HIGHWAY COMMISSION

HERBERT C. PETRY JR.	Chairman
CHARLES F. HAWN	Member
HAL WOODWARD	Member
D. C. GREER	State Highway Engineer

Texas Highways

TEXAS HIGHWAYS, official journal of the Texas Highway Department, is published in the interest of highway development in Texas and for departmental education in the improvement of construction, maintenance, and operation.

TEXAS HIGHWAYS is available to the general public on a subscription basis at $3.50 annually, or it can be purchased for 35 cents a copy. Subscriptions, inquiries, material, or manuscripts should be directed to the Editorial Office, Travel and Information Division, Texas Highway Department, Austin 14, Texas.